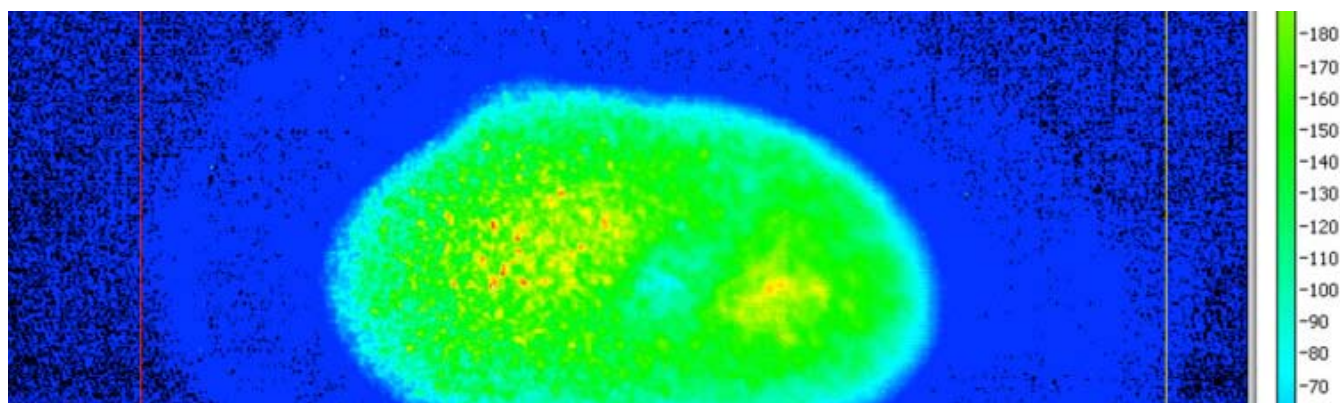


AROUND THE WORLD

Understanding electron beam halos

Jefferson lab physicist aims to develop large dynamic range diagnostics for electron linacs

by Christine Herman (FNAL)



The halo of an electron beam does not make it angelic. It only adds to the beam's messy profile, making more work for physicists like Jefferson Lab's Pavel Evtushenko, who was recently awarded funding for five years to look into developing high-range dynamics beam diagnostics that could help clean up electron beams.

FEATURE

The pursuit of polarised positrons

The sixth POSIPOL workshop held at IHEP, Beijing

by Min Zhang



Researchers gather in Beijing to discuss the latest and future research on positron sources for a next-generation linear collider at this year's POSIPOL workshop.

DIRECTOR'S CORNER

Celebrating the Tevatron

by Barry Barish



The Fermilab Tevatron will be turned off later this month after having served the high-energy community for 25 years as the highest-energy collider in the world. The contributions of the Tevatron have been enormous, both from its many physics results and from its leading role in developing the science and technology of high-energy hadron colliders.

IMAGE OF THE WEEK



Super scientists stand symmetrically

Image: Reidar Hahn

Participants in the [SUSY 2011](#) conference held from 28 August to 3 September at Fermilab.

IN THE NEWS

from **New Scientist**

7 September 2011

[Third experiment sees hints of dark matter](#)

The new result comes from an experiment called CRESST II which uses a few dozen supercooled calcium tungstate crystals to hunt for dark matter from deep beneath the Gran Sasso mountain in Italy.

from **BBC News**

7 September 2011

[Dark matter hinted at again at Cresst experiment](#)

Researchers at the Cresst experiment in Italy say they have spotted 67 events in their detectors that may be caused by dark matter particles called Wimps.

from **NPR**

6 September 2011

[A Final Smash For America's Giant Particle Collider](#)

The Tevatron has been the pride of the Fermi National Accelerator Laboratory for a quarter of a century. But at the end of this month the Tevatron is shutting down.

from **New Scientist**

6 September 2011

[Antimatter surplus is not dark matter's smoking gun](#)

Antimatter enthusiasts will love it; dark matter hunters not so much. NASA's FERMI satellite has confirmed a previous hint that there is more antimatter than expected coming from space. The bad news is that the result almost certainly rules out dark matter as the source.

from **Reuters**

5 September 2011

[Month-end target mooted for finding "no Higgs"](#)

U.S.-based physicists said on Monday they hope to have enough data by the end of this month to establish if the elusive Higgs boson a particle thought to have made the universe possible exists in its long-predicted form.

from **SLAC**

31 August 2011

[A PEP City Farewell](#)

Branded "temporary" when they were built in 1966 and threatened with demolition more than once during the past 35 years the dozen portable classroom buildings and office trailers known as "PEP City" are being torn down this week.

from **msnbc.com**

31 August 2011

[Atom smashing hype faces reality](#)

The latest results from the Large Hadron Collider serve as a reality check for expectations that radical scientific discoveries are just around the corner.

from ***National Geographic***

31 August 2011

[Dark Matter Is an Illusion New Antigravity Theory Says](#)

The mysterious substance known as dark matter may actually be an illusion created by gravitational interactions between short-lived particles of matter and antimatter a new study says.

CALENDAR

UPCOMING EVENTS

[The 2nd International Particle Accelerator Conference \(IPAC'11\)](#)

San Sebastian, Spain

04- 09 September 2011

[JSPS specially promoted research: "A global R&D program of a state-of-the-art detector system for ILC"](#)

Sendai, Japan

12- 14 September 2011

[LC11: Understanding QCD at Linear Colliders in searching for new and old physics](#)

ECT*, Trento, Italy

12- 16 September 2011

[CALICE Collaboration Meeting](#)

Heidelberg, Germany

14- 16 September 2011

[Linear Collider Workshop 2011 \(LCWS11\)](#)

Granada, Spain

26- 30 September 2011

UPCOMING SCHOOLS

[CERN Accelerator School: Course on Accelerator Physics](#)

University of Chios, Chios, Greece

18- 30 September 2011

[View complete calendar](#)

PREPRINTS

ARXIV PREPRINTS

[1109.0927](#)

Concept and status of the CALICE analog hadron calorimeter engineering prototype

[1108.6275](#)

Time evolution of ground motion-dependent depolarisation at linear colliders

AROUND THE WORLD

Understanding electron beam halos

Jefferson lab physicist aims to develop large dynamic range diagnostics for electron linacs

Christine Herman (FNAL) | 8 September 2011

Some physicists joke about electrons, saying that you cannot collimate them, you can only make them angry.

Collimation is the removal of low-intensity, high-amplitude particles from a particle beam, typically by absorption into a metal. These unwanted particles, which make up what's known as the halo, could cause high backgrounds in collision data and wreak havoc on detector components.

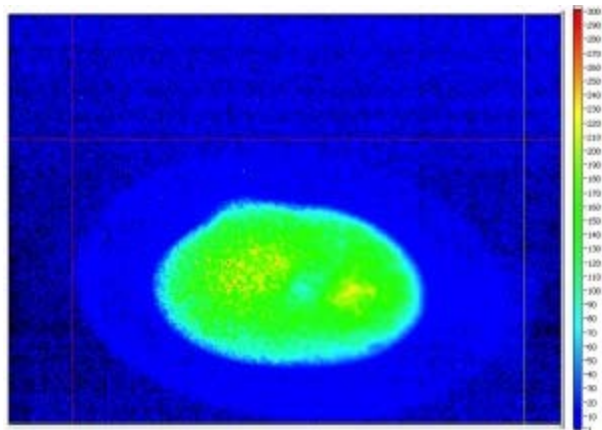


Figure 1. Lower-dynamic-range transverse beam profile measured in Jefferson Lab's free-electron laser injector. The blue halo intensity is about 300 (arbitrary units) less than that of the green core. Image courtesy of Pavel Evtushenko

Pavel Evtushenko, physicist at Jefferson Lab in the US, hopes his work will help create clean, tight electron beams for future electron-positron collision experiments such as those at the ILC. He and his colleagues in the laboratory's Free Electron Laser Division are developing tools to perform improved beam diagnostics and beam dynamics studies for high-current electron linacs.

This year Evtushenko was awarded the US Department of Energy Office of Science [Early Career Research Award to develop high-dynamic-range diagnostics](#) for linear particle accelerators.

"Pavel's been one of our brightest young scientists," said George Neil, who leads the Free Electron Laser Division. About seven years ago, Neil met Evtushenko in Germany. "As soon as I met him, I said, 'I've got to have that guy here at Jefferson Lab.' So I began my not-so-subtle arm twisting to convince him to come over and join our group."

With his recent award, Evtushenko will spend the next five or so years developing experiments to better diagnose the conditions that form halos around electron beams.

Not all particle beam halos are created equal. Gaussian proton beams, such as those at the Tevatron and LHC, are characterised by halos that reside around the edges and are typically removed by placing in the beam's path tungsten blocks, which absorb protons in the halo.

Electron beam profiles, on the other hand, are highly variable and poorly defined as halo particles reside throughout the beam and are more difficult to remove. When electrons strike a collimator, instead of being absorbed, they can be scattered back into the beam with altered trajectories, so creating an irritating new halo. Good-humoured physicists often refer to this as the electrons getting angry.

"It's a joke, but there's some truth in it," Evtushenko said.

The three-pronged goal of Evtushenko's research is to develop a high-dynamic-range technique to measure the profile of an electron beam, use the technique to study beam dynamics and evolution over space and time, and develop solutions for manipulating and controlling the beam, including removing the pesky halo.

The dynamic range of an instrument is the ratio between the largest and smallest values it can measure. For example, a digital camera has a dynamic range equivalent to the ratio between the largest and smallest measurable light intensities it can capture. With a high-dynamic-range camera, a photographer can take a picture of a sunset, capturing the bright sun and the shadows on the water in a single shot.

Measuring the profile of an electron beam is like taking a picture of the beam's cross-sectional area. An electron beam profile has peaks and valleys, which, by current methods, can be measured with diagnostics with a dynamic range of 1,000.

With today's ever-increasingly powerful computers, researchers simulate electron beams of millions of particles, including those that make up the halo. To test the reliability of these simulations, Evtushenko would like to match the computers' kind of dynamic range – a range of about 1,000,000 – in beam diagnostics instruments. If tests using high-dynamic-range diagnostics bear out the high-precision simulation results, then scientists can use computers to do many of the studies rather than going into the lab to make time-consuming measurements.

Evtushenko's proposal involves upping the dynamic range through a variety of techniques. One is to use so-called laser wire to get a better picture of the beam's longitudinal shape. Both of Jefferson Lab's accelerators, the CEBAF and the accelerator that powers the free-electron laser, generate continuous-wave electron beams at very high repetition rates, in contrast with a beam with more separated bunches. It affords researchers the opportunity to use ultra-short laser pulses, or laser wire, to measure the electron beam profile. Higher average current and high repetition rate ease the task of making longitudinal phase space measurements of the beam and enable higher dynamic range measurements.

Another technique is to use an imaging method similar to that used in astronomy, where different celestial bodies and lights are imaged with different exposure times, all of which are later pieced together to form a clearly rendered whole. With a zipping particle beam, of course, one can't take much liberty with time, so the challenge is to quickly image different parts of the particle beam using different gains suited to the part of the beam being imaged. An algorithm helps put together the high-dynamic-range profile.

Trying to get that kind of clarity with frenetic, angry electron beams won't be simple. "But I guess if any of this were easy, it would have been done already," Evtushenko said.

It's worth the trouble for cleaner beams.

"If we can learn to predict the sources of these small parts of the beam outside the bulk and then control or reduce the level, we can make more powerful beams that won't destroy themselves," Neil said.

Evtushenko plans to use the technique he develops to capture an image of the low-energy beam shortly after it emerges into the accelerating cavity.

"It's very encouraging to get approval for this work," Evtushenko said, referring to the [DOE award](#). He's happy to be involved in work that will help bring about the next generation of light sources, he said. And, he hopes he can keep the electrons happy, too.

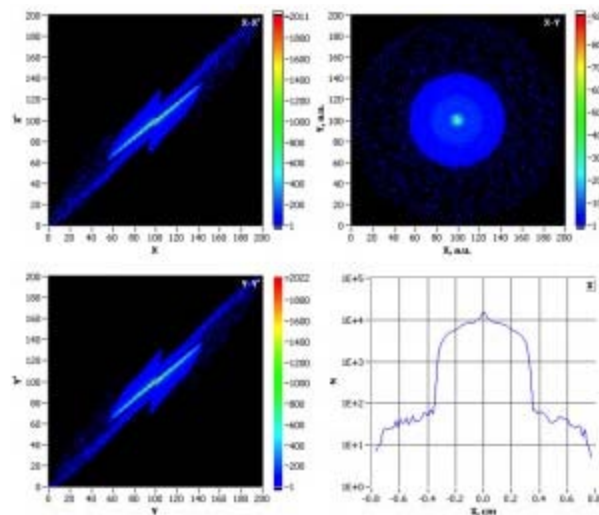


Figure 2. The same beam profile as Figure 1, this time from numerical simulations. Upper right: Transverse beam profile. Upper left, lower left: Transverse beam phase space distribution, demonstrating the development, due to the nonlinear beam dynamics, of the halo. Image courtesy of Pavel Evtushenko

FEATURE

The pursuit of polarised positrons

The sixth POSIPOL workshop held at IHEP, Beijing

Min Zhang | 8 September 2011



Participants of the POSIPOL 2011 workshop

The [POSIPOL 2011 workshop](#) was held from 28 to 30 August at the Institute of High Energy Physics (IHEP), Chinese Academy of Sciences in Beijing. It was the sixth in the POSIPOL series of workshops coupling the polarised positron source R&D efforts of next-generation electron-positron colliders such as the ILC and the Compact Linear Collider (CLIC) Study to more general polarised-positron community.

More than 30 scientists from Asia, Europe and the US attended the workshop, including some via videoconference. "The main goal of this workshop is to speed up the steps for realising required polarised positron beams for ILC, CLIC, SuperB [a future electron-positron collider in Italy], and inverse Compton scattering sources in general," said Jie Gao, chair of POSIPOL 2011 and of the Asian linear collider

steering committee. In total, 25 talks were given during the workshop, including talks on physics, colliders, gamma ray generation, targets, conventional positron sources, polarimeter, capture section, spin tracking and Compton scattering X-rays.

Researchers said that much progress has been made since the [POSIPOL 2010 workshop](#) held at KEK in Japan. As for the ILC, scientists held in-depth discussions on collimator studies for the undulator-based positron source, targets, and gamma ray generation at the Accelerator Test Facility (ATF). Concerning CLIC, studies on hybrid targets with a non-polarised positron source, a capture section study, and a proposal on polarised positron Compton ring, which is superconducting stacking-ring-based, were discussed.

Looking forward, there are many studies still to be carried out. A group at Lawrence Livermore National Laboratory in the US will work on prototype of flux concentrator for the ILC, and will begin designing a collimator. A positron target unit material experiment will be carried out at DESY. Gamma ray experiments with four mirror cavities at ATF will continue. Further evaluation on target stress and optimisation of capture parameters are needed; remote handling study will start. For the CLIC non-polarised positron source, "it is crucial to implement test facilities, and the SuperB experiment is the only one currently existing, which is an important step forward for the positron source," said Gao in his summary talk.

Participants paid a visit to the [National Art Museum of China](#) and enjoyed a banquet at Beijing 798 Art Zone. "The combination of the classical and modernism of these two places impressed me a lot," said Kaoru Yokoya, Global Design Effort Asian regional director.

The POSIPOL 2012 workshop will be held at DESY in Zeuthen, Germany.



Jie Gao gives a summary talk at the workshop



The workshop banquet was held at a western-style restaurant at Beijing 798 Art Zone. Diners talk, laugh and make faces for the camera.

[IHEP](#) | [POLARISED POSITRON BEAM](#) | [POSIPOL](#) | [POSITRON SOURCE](#) | [POSITRON TARGET](#)

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DIRECTOR'S CORNER

Celebrating the Tevatron

Barry Barish | 8 September 2011



Aerial view of the Fermilab Tevatron complex. Image: Fermilab

[complex](#) by Steve Holmes of Fermilab.

The Division of Particles and Fields (DPF) of the American Physical Society held a major conference for the field at Brown University in Providence, Rhode Island from 9-13 August. A very interesting feature of the meeting was a celebration of the Tevatron, in anticipation of its being turned off later this month. The CERN Large Hadron Collider is replacing it as the primary facility to study high energy hadron collisions. At DPF, the [physics accomplishments of the Tevatron](#) were reviewed and celebrated by Paul Grannis of Stony Brook University, and the history and impressive evolution of the [Tevatron collider](#)

In the 1960s, the “National Accelerator Laboratory” was conceived and funded by the US government as a new laboratory that would house the most ambitious accelerator in the world, a 400-GeV proton synchrotron. Under the leadership of Robert Wilson, the machine was built as a fixed-target facility that quickly became a major laboratory studying a broad range of high-energy physics experiments. In fact, I personally became involved in developing neutrino beams and studying high-energy neutrino collisions.

Despite the success of the original accelerator and important physics results, the quest for yet higher energies remained very strong. At Fermilab, a programme was undertaken to double the energy of the machine by making it a superconducting accelerator. A large and successful effort resulted in developing the magnets that would make this possible. But doubling the energy would not get to the energy scale needed and, as a result, the programme evolved towards making a proton-antiproton collider. By colliding beams of protons and antiprotons, much higher energies in the centre-of-mass system can be achieved.

Fermilab adopted the approach of colliding protons with antiprotons, which required many new concepts and technologies, including making and storing large numbers of antiprotons. Over the period of the Tevatron collider, through innovative developments, the performance was increased by a factor of 400 compared to the initial collider performance.

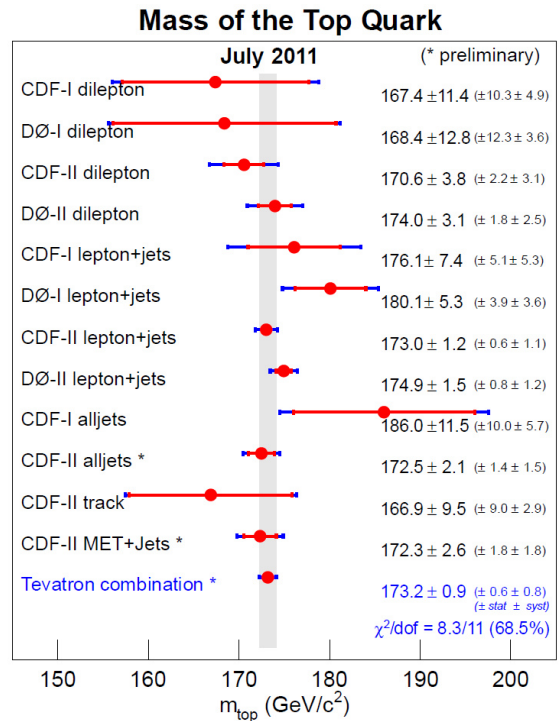
The physics from the Tevatron was accomplished by two large colliding-beam detectors, which have been precursors for the present generation of colliding-beam detectors at the LHC. Fermilab's CDF and D0 detectors began with quite different emphases, but as the physics became better known, and therefore the detector requirements, they evolved to become more alike. The physics programme as reviewed by Paul Grannis was characterised as covering six areas: (1) quantum chromodynamics (QCD); (2) heavy flavours; (3) searches beyond the Standard Model; (4) electroweak physics; (5) top quark; and (6) search for the Higgs.



Tevatron superconducting magnet. Image: Fermilab

The top quark was a key discovery that was made at the Tevatron simultaneously by the CDF and DØ detectors in 1995, after several years of searching until enough integrated luminosity was recorded to carry out the analysis at the level required to make the discovery. This was a very impressive achievement and following the discovery, a wide variety of measurements, including those of the production cross-section, mass, decay modes and other properties, have been produced and now continue at the LHC.

The Tevatron and the CDF and DØ detectors have been the centre of our field for several decades, yet they must now give way to the excitement (and soon discoveries) of the new LHC collider and its ATLAS, CMS and LHCb detectors. Nevertheless, Fermilab is planning to remain at the forefront of particle physics over the coming years by developing new high-intensity lower-energy accelerators. I join in celebrating the Tevatron and in wishing Fermilab success as it moves in new directions.



Measurements of the mass of the top quark

[AMERICAN PHYSICAL SOCIETY](#) | [APS](#) | [DIVISION OF PARTICLES AND FIELDS](#) | [DPF](#) | [FERMILAB](#) | [TEVATRON](#) | [TOP QUARK](#)

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